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Setting occupational exposure limits for carcinogens

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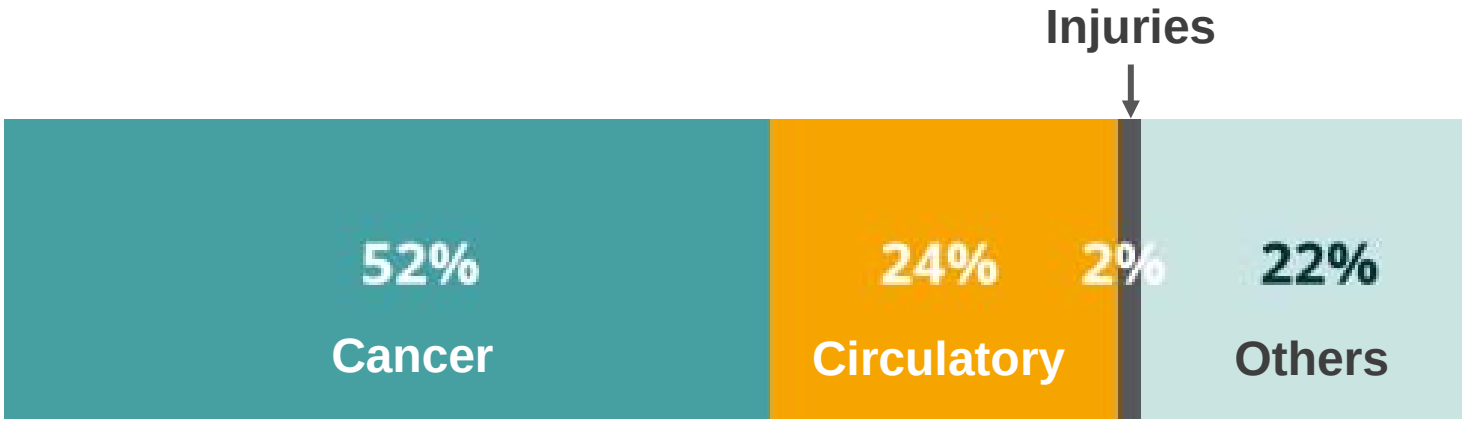
Half of the work-related fatalities in EU are caused by cancer



Causes of work-related fatalities in the EU-28
https://osha.europa.eu/en/publications/international-comparison-cost-work-related-accidents-and-illnesses

Over 100 000 workers die per year from work-related cancer in Europe
https://oshwiki.eu/wiki/Eliminating_occupational_cancer_in_Europe_and_globally

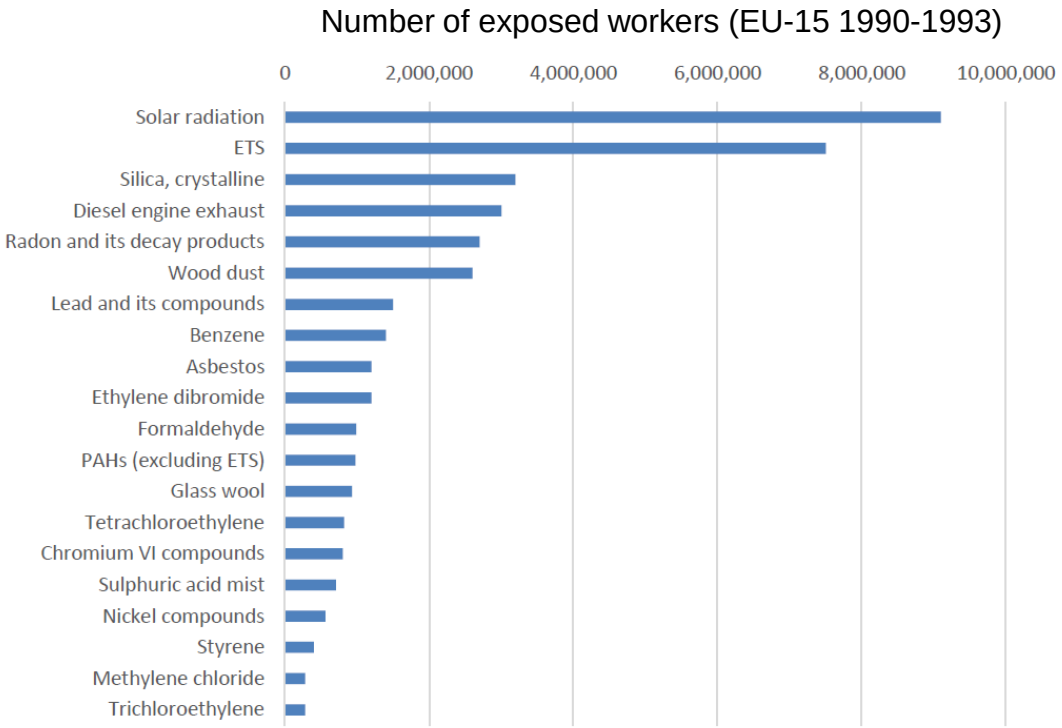
Most common cancer agents

Number of exposed workers

1. Solar radiation
2. ETS
3. Silica
4. Radon
5. Diesel engine exhaust

Number of cancer cases

1. Asbestos
2. Shift work
3. Mineral oils
4. Solar radiation
5. Silica



EU OSHA 2014 https://osha.europa.eu/en/publications/exposure-carcinogens-and-work-related-cancer-review-assessment-methods

Many approaches to control cancer agents at work

- Ban, restrictions
- As low as reasonably achievable – ALARA
- Prevention measures – STOP
- Occupational exposure limits – OELs

"OELs are a cornerstone to reduce dangerous chemical exposures at work"

Bertil Remaeus, former chair, EU-OSHA Governing Board

EU OSHA 2018 https://osha.europa.eu/en/publications/info-sheet-legislative-framework-dangerous-substances-workplaces/view

Two types of OELs in the EU

Indicative OELs

- Established for chemicals with a threshold
- Threshold – exposure level below which adverse health effects do not occur
- “Health-based”
- Chemical Agents Directive (CAD)

Binding OELs

- When a threshold mechanism is not known
- Carcinogens, mutagens and airway sensitisers
- “Risk-based”
- Carcinogens and Mutagens Directive (CMD) and CAD

Both are set for a typical 8-h working day

- Time weighted average
- 8 h/day, 5 days/week, 40 years

SCOEL 2017, https://op.europa.eu/en/publication-detail/-/publication/3c8ef3e0-48fc-11e8-be1d-01aa75ed71a1
ECHA 2019, https://echa.europa.eu/documents/10162/23036412/ircsa_r8_appendix_oels_en.pdf/f1d45aca-193b-a7f5-55ce-032b3a13f9d8

Important to consider both the number of workers affected and the risk to the individual

A high individual risk is unacceptable also when few workers are exposed

" Every worker has the right to working conditions which respect his or her health, safety and dignity "

Charter of Fundamental Rights of the European Union, Article 31-1
https://www.europarl.europa.eu/charter/pdf/text_en.pdf

" Everyone has the right to work, to free choice of employment, to just and favourable conditions of work and to protection against unemployment "

Universal Declaration of Human Rights / United Nations, Article 23-1
https://www.ohchr.org/EN/UDHR/Documents/UDHR_Translations/eng.pdf

”Traffic light model” as a tool for risk management

Extra cancer risk per year at work

10^{-6} 1 in 1 000 000

10^{-4} 1 in 10 000

Extra cancer risk per working life

$4x10^{-5}$ 40 in 1000 000

$4x10^{-3}$ 40 in 10 000

Low risk
No demands for measures, but lower if possible

Medium risk
Tolerable for a limited period, but measures should be taken to reduce expsoure

High risk
Immediate actions are required to reduce exposure

Germany	Acceptable risk	Tolerable risk
Netherlands	Target risk level	Prohibitive risk level
Austria	Target value	Critical value

Some of the current binding OELs are associated with high cancer risks

Crystalline silica

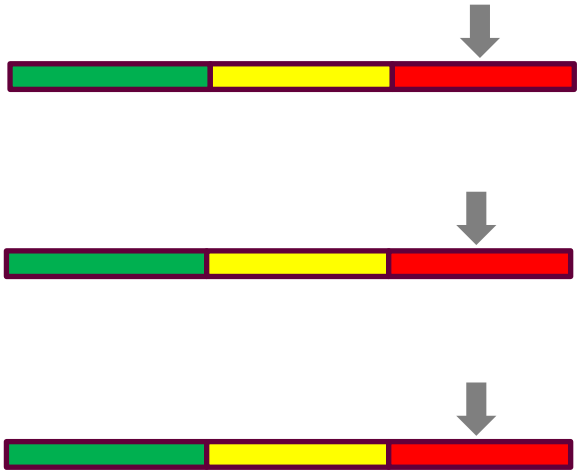
11 to 54 cancer deaths per 1000 workers

Hexavalent chromium

20 extra lung cancers per 1000 workers

2-Nitropropane

28 tumours per 1000 workers (based on animal data)



Life-time extra cancer risk, linear non-threshold extrapolation, assuming lifelong exposure at work at the current binding OEL, based on US OSHA and SCOEL cancer risk assessments

Johanson & Tinnerberg, 2019 (https://pubmed.ncbi.nlm.nih.gov/30969344/)

How derive an OEL for a carcinogen?

- What is the acceptable risk level?
- How calculate the cancer risk at work-relevant exposures?

Use of human data

Many people get cancer for a variety of reasons (genetic, environmental)

All are exposed to a variety of agents

$\Rightarrow$ difficult to identify an exposure factor that causes cancer in 4 of 1000 workers

Use of animal and in vitro data

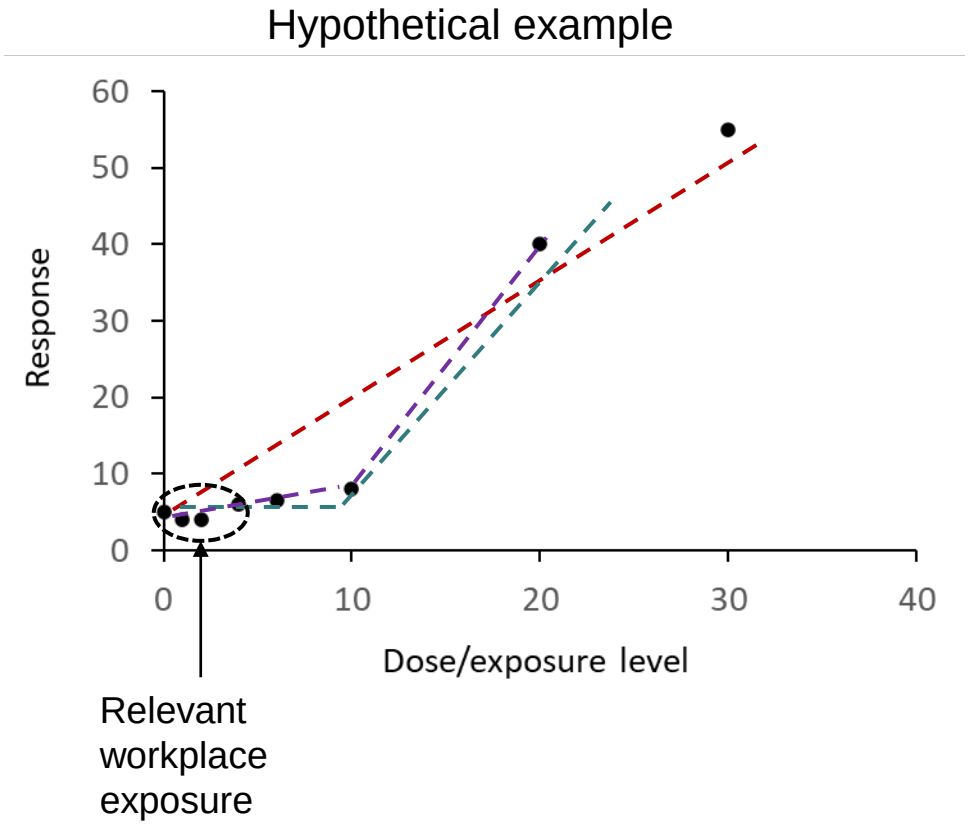
Good control of the exposure, but

- high doses needed to detect an effect – how translate to far lower exposure levels at work?
- does the chemical cause the same effect in humans as in the test system?

What is the risk at relevant exposure?

- How to extrapolate from high dose – high risk (where we have data) to low dose – low risk?
- Is there a threshold, i.e. no cancer risk below a certain dose ?

How extrapolate to low dose? Threshold or no threshold?

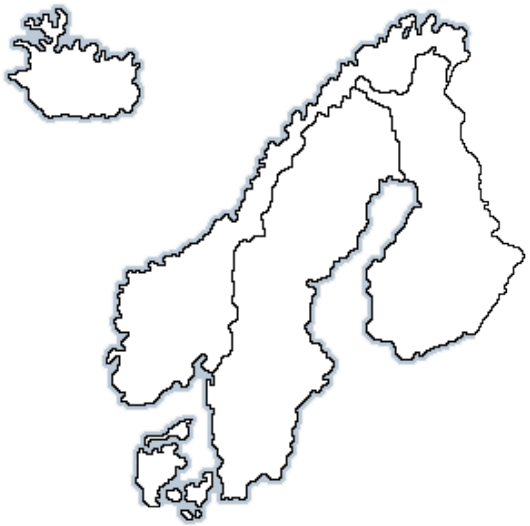


Threshold model
– zero excess risk below threshold
Health-based OEL set below threshold

Linear no threshold model
– any exposure entails increased risk
Risk-based OEL

Hockey-stick model
– two dose-response slopes

Read more in Hartwig et al, 2020
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7303094/



Ongoing work:

The Nordic Expert Group for Criteria Documentation of Health Risks from Chemicals

Approaches for OEL setting of carcinogens

https://www.av.se/en/the-nordic-expert-group